High-Resolution Seismic Surveying for Neogene-Quaternary Sequence Stratigraphy, Northern California Continental Shelf and Upper Slope, in Support of STRATAFORM

Craig S. Fulthorpe
University of Texas, Institute for Geophysics
4412 Spicewood Springs Road, Bldg. 600
Austin, TX 78759-8500
phone: (512) 471-0459 fax: (512) 471-8844 email: craig@utig.ig.utexas.edu

James A. Austin, Jr.
phone: (512) 471-0450 fax: (512) 471-8844 email: jamie@utig.ig.utexas.edu

Award #: N00014-96-1-0359
(AASERT Award #: N00014-97-1-0555)
http://www.ig.utexas.edu

LONG-TERM GOALS

This project is a component of ONR's STRATAFORM program, the goal of which is to link short-term (i.e., acting over hours to weeks) biological and physical processes affecting sedimentation ("event stratigraphy") to the sequence stratigraphy and facies architecture of the preserved record. STRATAFORM consists of three interrelated projects whose goals are to study: 1) shelf sediment dynamics and the development of lithostratigraphy, 2) slope geological processes and resultant geomorphology, and 3) stratigraphic sequences resulting from shelf and slope sedimentation. High-resolution multichannel seismic (MCS) data collection, described below, is part of the third project, but the data also form part of a multi-faceted approach that ties all three projects together.

OBJECTIVES

Specific objectives include: 1) origins of sequence stratigraphic architecture in an environment characterized by high rates of sediment supply, 2) tracking the history of northward sediment dispersal from the Eel River and identifying sediment transport pathways that existed during sea-level lowstands, 3) morphologies and evolution of slope canyons, and 4) history of the Humboldt Slide.

APPROACH

STRATAFORM participants are documenting the stratigraphy of the continental shelf and slope of the Eel River Basin, northern California margin, at a variety of spatial scales (lateral and vertical) and in three dimensions (3-D). The key to this entire effort is the collection of "nested" geophysical and geological data, through use of a variety of tools whose individual temporal and spatial scales overlap to form a wide-ranging continuum of measurements.

WORK COMPLETED

High-resolution 2-D MCS profiles were collected from the outer shelf to slope, offshore Eel River Basin jointly by the University of Texas Institute for Geophysics (UTIG) and Lamont-Doherty Earth

Report Documentation Page					*Form Approved* *OMB No. 0704-0188*
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302 Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number					
1. REPORT DATE **30 SEP 1999**		2. REPORT TYPE			3. DATES COVERED **00-00-1999 to 00-00-1999**
4. TITLE AND SUBTITLE **High-Resolution Seismic Surveying for Neogene-Quaternary Sequence Stratigraphy, Northern California Continental Shelf and Upper Slope, in Support of STRATAFORM**					5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)					5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of of Texas at Austin,Institute for Geophysics (UTIG,4412 Spicewood Springs Road, Bldg. 600,Austin,TX,78759**					8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)					10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**5**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Observatory (L-DEO) in July - August 1996. The seismic system, developed and owned by L-DEO, included a 48-channel I.T.I. streamer, 45/45 cu. in. G.I. air gun and OYO DAS-1 recording system. A backup Geco streamer was used for part of the survey. The survey was designed to image stratal geometries at a scale intermediate between those of the existing very-high-resolution (500-3500 Hz) Huntec deep-towed seismic profiles and commercial MCS data, fulfilling the STRATAFORM goal of providing "nested" seismic coverage (several Huntec and commercial lines were duplicated). The seismic grid surveyed consists of 84 lines (~2200 km; Figure 1). Line spacings vary, but a spacing of 800 m was maintained, where possible, in both dip and strike directions. Such dense coverage was necessary to provide the 3-D stratigraphic perspective mandated by STRATAFORM. Vertical resolution is ~5m. Data processing is being shared by UTIG and L-DEO (L-DEO P.I.: G.S. Mountain). UTIG has now processed all but one of its 41 lines to the stage of post-stack migration. Interpretation to date has focussed on the shelf and will be extended to the slope.

RESULTS

During the current sea-level highstand, sediment transport on the shelf is governed by wind and currents. These are generally directed to the north during the large winter storms that provide most of the suspended sediment input (Cacchione et al., 1999). In contrast, part of the shelf was exposed during sea-level lowstands, as indicated by large, buried channels (Figure 2). These channels deepen toward the southwest and appear to converge on the Eel Canyon. Repeated convergence on the canyon during multiple incision events indicates that Eel Canyon has existed through multiple cycles of relative sea-level change, whereas each set of shelf channels is incised and filled within a single sea-level cycle. The channels are presumed to be mainly the result of fluvial incision, although probably not related to Eel River drainage: their NE-SW course suggests a more northerly source. The maximum depth of incision (up to ~250 m near the canyon) suggests that the seaward ends of the systems may have been produced by submarine erosion, headward from Eel Canyon.

Slope channels are of at least two distinctive types. 1) Shallowly buried (~40 m) aggrading gullies, ~20 m deep, are spaced at 300 - 600 m intervals. Cycles of erosion alternate with periods of draping during which gully morphology is retained (Field et al., 1999). Sequence stratigraphic interpretation may confirm whether the erosional episodes occur during periods of low sea level. 2) Northward of the aggrading gullies are larger buried channels, or canyons up to ~120 m deep and 1 km wide. These channels are erosional and exhibit lateral migration and erosion of fill by subsequent channeling.

The new MCS will help determine whether the strike-parallel ridges within the Humboldt Slide zone are structural features related to slope failure or bedforms (Gardner et al., 1999). The data reveal what may be earlier, buried failure surfaces, with high-amplitude seismic reflections, possibly indicative of trapped gas-charged fluids, immediately landward of the buried headwall scarps.

IMPACT/APPLICATIONS

The MCS data: 1) fill the gap in seismic resolution and depth of penetration between existing data sets to provide fully "nested" coverage, 2) link outer shelf and upper slope stratigraphic regimes, and 3) allow development of models that will determine the transfer functions between modern sedimentary processes and stratigraphic preservation.

TRANSITIONS

Mobil has shown interest in processing some lines in order to assist with multiple removal.

RELATED PROJECTS

The MCS data have been used to select sites for long (up to 150 m) cores (STRATAFORM Deep Coring Workshop, October 1998). These cores will provide ground truth for nested MCS and shallow-penetration Huntec (deep-towed boomer) profiles. We have provided profiles to Mike Field and Glenn Spinelli (USGS), for integration with Huntec profiles, and Dan Orange and Janet Yun (University of California, Santa Cruz), to augment deep-penetration commercial MCS profiles.

REFERENCES

Cacchione, D.A., Wiberg, P.L., Lynch, J., Irish, J., and Trayovski, P., 1999, Estimates of suspended-sediment flux and bedform activity on the inner portion of the Eel continental shelf, *Marine Geology*, v. 154, p. 83-97.

Field, M.E., Gardner, J.V., Prior, D.B., 1999, Geometry and significance of stacked gullies on the northern California slope, *Marine Geology*, v. 154, p. 271-286.

Fulthorpe, C.S., Mountain, G.S., Austin, J.A., Jr., Buhl, P., Diebold, J., Goff, J.A., Schuur, C.L. and Yun, J., 1996, STRATAFORM high-resolution MCS survey, Eel River Basin, northern California margin: shelf/slope stratigraphy and processes, (abstract), *Eos, Transactions, American Geophysical Union*, supplement to v. 77, No. 46, p. F330.

Gardner, J.V., Prior, D.B., and Field, M.E., 1999, Humboldt Slide – a large shear-dominated retrogressive slope failure, *Marine Geology*, v. 154, p. 323-338

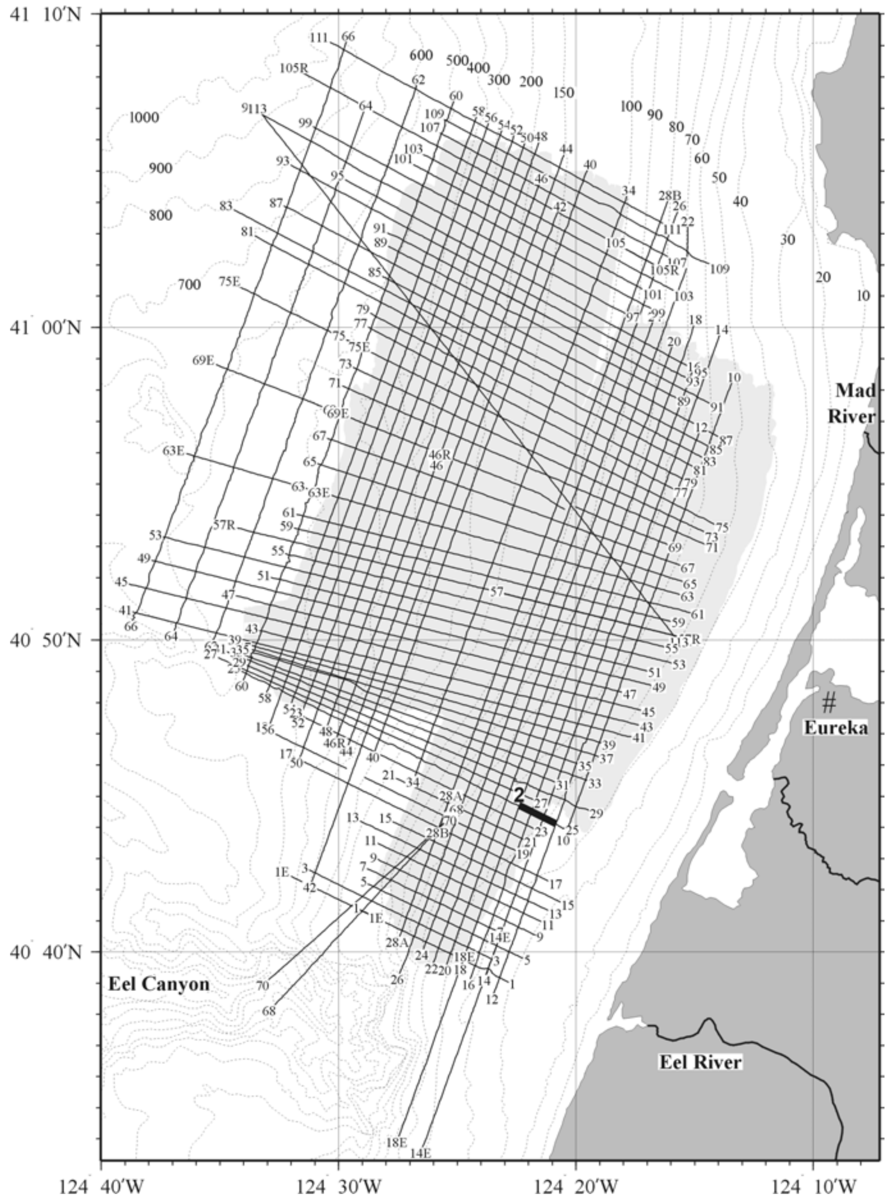

Figure 1. Survey track showing numbered MCS lines collected by R/V Wecoma during STRATAFORM high-resolution MCS operations. UTIG and L-DEO are each responsible for processing half of the data: each has a subset of the data comprising roughly alternating lines of the grid displayed. The shaded pattern notes the region of STRATAFORM swath bathymetry/backscatter data acquired by L. Mayer and J. Goff during summer 1995. Profile segment displayed in Figure 2 (line 25) is highlighted. Bathymetry in meters.

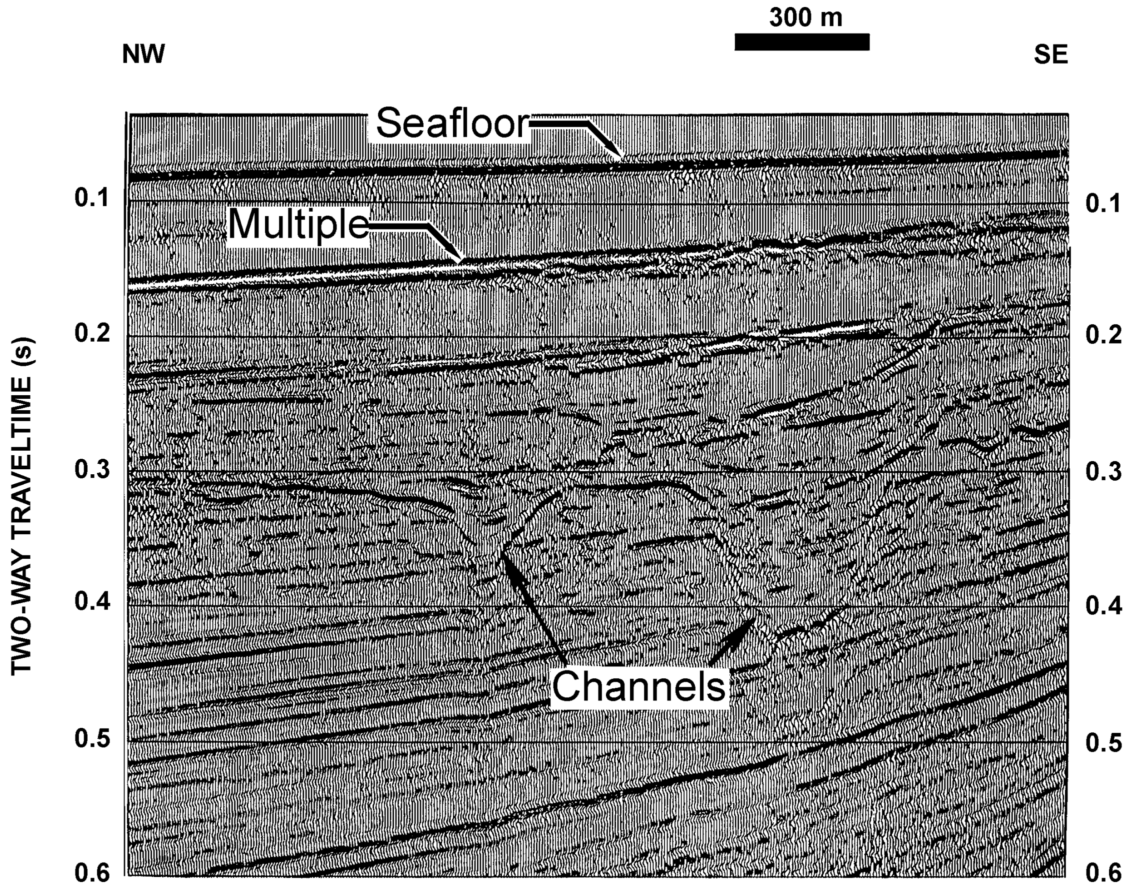

Figure 2. High-resolution MCS profile (line 25) from the Eel River Basin showing buried channels beneath the shelf. Such channels are products of fluvial incision during sea-level lowstands; mapping suggests that they represent a fluvial system north of the present-day Eel River. The strong reflection at ~0.5 s is the first seafloor multiple. Location of this profile is shown in Figure 1